The Adjunctive Soft-Tissue Diode Laser in Orthodontics

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ABSTRACT: Lasers are a relatively new addition to the orthodontist's armamentarium. This article reviews the fundamental basic science of available soft-tissue lasers, with an emphasis on diode lasers, and discusses various adjunct applications of the diode laser for soft-tissue orthodontic procedures. Diode lasers function by cutting with an initiated hot tip and produce minimal to no interaction with healthy dental hard tissue, making them suitable for soft-tissue procedures. The contact cutting mode provides enhanced bloodless site visibility and facility to perform delicate soft tissue procedures, which is important in areas with difficult access. Such adjunctive uses include laser gingivectomy to improve oral hygiene or bracket positioning, esthetic laser gingival recontouring, and laser exposure of superficially impacted teeth. Selected cases treated with a 940-nm indium-gallium-arsenide-phosphide (InGaAsP) diode laser will be presented.

LEARNING OBJECTIVES		
• Discuss advantages of laser excision over scalpel surgery for use in orthodontic therapy.	• Describe the various ways lasers can be used for soft-tissue procedures.	• Explain differences between deeply penetrating types of soft-tissue lasers and superficially absorbed lasers.

The gingiva has a complex topography, and compared to a scalpel, a laser beam can more easily cut, ablate, and reshape the soft tissues in the oral cavity with no or very limited bleeding, less pain, and with no or less need for suturing.[1] This encompasses a spectrum of tissue interactions, such as warming the tissue, welding, coagulation, protein denaturation, drying, and, finally, vaporization (ablation) and carbonization, where soft tissues are evaporated or incised.[1-7] This process collectively provides hemostasis, microbial inhibition and destruction, and photobiomodulation (PBM).[1-7] In particular, there is increasing evidence that the appropriate use of lasers is associated with reduced intraoperative and postoperative pain and increased wound healing or tissue regeneration, compared to conventional scalpel usage or electrosurgery.[1-4] Literature suggests that electrosurgery can be used for incising soft tissues with good hemostasis[1,5]; however, it comes with a risk of delayed wound healing due to unwanted thermal damage[1,6] and necrosis of the underlying periosteum and alveolar bone.

Laser Excision/Incision Vs. Scalpel Surgery

Dental lasers are used for soft-tissue procedures such as gingivectomy, gingivoplasty, frenectomy, and excision of benign connective

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tissue inflammatory hyperplastic lesions such as fibrous hyperplasia.[8-10] In particular, lasers have proven to be effective for esthetic gingival procedures or as an adjunct to restorative dentistry, such as in recontouring of gingiva, depigmentation, and crown lengthening.[1,11] Compared to conventional scalpel surgery, the diode laser cut is more precise and easier for the clinician to see because of the simultaneous cut and hemostasis effect.[1,7,8,12] This leaves a clear and dry field, with minimal or no surgical bleeding.[1,7,8] The laser also sterilizes as it cuts, and residual bacteria are evaporated, destroyed, or denatured by laser irradiation.[1] Furthermore, the need for sutures is usually minimal.[8]

Laser incision with high-level laser therapy (HLLT) excises (ablates) diseased tissues, with simultaneous provision of low-level laser therapy (LLLT) that penetrates or scatters into the surrounding tissues during HLLT and stimulates tissues and cells without producing irreversible changes. LLLT promotes periodontal wound healing of the adjacent tissues as a desired effect,[1,13,14] a process known as photobiomodulation (PBM) of tissues and cells following laser irradiation (Table 1).[1] PBM can promote changes at the cell level and expression of cytokines that collectively promote wound healing by increasing collagen production, reducing inflammation, and supporting pain relief.[1,15-61] Less wound contraction and edema also occur during mucosal healing; scars tend not to develop because less collateral damage occurs and periodontal dressing is rarely required.[7,62-65] These effects are attributed to the low-power (PBM) zones that surround the high-power surgical laser site,[58] allowing faster or more favorable wound healing that requires less pain medication[8] and leading to less postoperative discomfort compared to conventional scalpel surgery.[1] The orthodontic treatment time can be shortened when soft-tissue procedures are needed that otherwise would require referral to other specialties such as a periodontist or oral surgeon. Therefore, the adjunctive use of soft-tissue lasers in orthodontics can attract fee-paying patients who demand optimal results in a timely fashion with minimal alterations in their eating and speech functions.[8,62-65]

Laser Wavelengths for Soft-Tissue Procedures

Various laser wavelengths have been used for soft-tissue procedures; lasers work by ablating, incising, and excising the soft tissue, providing the much-needed coagulating effect. Frequently used soft-tissue lasers include: carbon dioxide [CO_2] (9600 nm to 10600 nm); erbium (erbium-doped yttrium-aluminum-garnet [Er:YAG] (2940 nm) and erbium chromium-doped yttrium-scandium-gallium-garnet [Er,Cr:YSGG] (2780 nm)); neodymium doped yttrium-aluminum-garnet [Nd:YAG] (1064 nm); and diode (800 nm to 980 nm).[1]

Shallow or Deeply Penetrating Lasers and Hemostasis

Soft-tissue lasers can be sorted into two categories: deeply penetrating type lasers (near-infrared spectrum; approximately 800 nm to 1100 nm) and superficially absorbed lasers (CO_2, Er:YAG, and Er,Cr:YSGG). The deeply penetrating type lasers, such as diode and Nd:YAG lasers, are essentially transmitted through water, showing a lower absorption coefficient in water.[66] This explains their deep penetration into healthy soft tissue, in which the laser light infiltrates and scatters deeply.[66] However, these lasers are selectively absorbed in areas of inflammation by blood components and tissue pigment (hemoglobin and melanin).[66] There is also minimal to no interaction of Nd:YAG and diode lasers with healthy dental hard tissue (ie, not covered by calculus), which makes them suitable for soft-tissue procedures.[66] The Nd:YAG laser is often used in pulsed mode, with very short duration pulses and an emission cycle (ratio of "on" time to total treatment

TABLE 1: EFFECTS OF PHOTOBIOMODULATION (PBM) ON FOUR PHASES OF WOUND HEALING

Four Phases of Wound Healing	Effects of PBM on Wound Healing
Hemostatic Phase	Promotes platelet aggregation and activation
Inflammatory Phase	Promotes proliferation and degranulation of mast cells
Proliferative Phase	Promotes proliferation of fibroblasts, keratinocytes, osteoblasts, and chondrocytes and induces matrix synthesis
Maturation Phase	Improves reorganization and remodeling of wounds, helps improve tensile strength, and aids in restoring functional architecture of repaired tissues

time) of <1% and very high peak power per pulse (100 W to 1000 W).[66] The Nd:YAG laser produces a relatively thick coagulation layer on the lased soft-tissue surface, exhibiting strong hemostasis, and, therefore, is effective for ablation of potentially hemorrhagic soft tissue. Diode lasers, representing a shallower penetration depth compared to Nd:YAG lasers, are less likely to cause pulpal damage after use.[63] Diode lasers are used with power outputs ranging up to 20W, in a continuous-wave or pulse mode[7] and are ideal for use in orthodontic set-up due to the relatively small size of the laser device and lower cost.[67]

With the second category of soft-tissue lasers—the superficially absorbed lasers—the laser beam is absorbed in the superficial layer of tissue and does not penetrate or scatter deeply.[1,68,69] These lasers have higher absorption coefficient in water and, due to the high water content of oral mucosa (>90%), are very effective soft-tissue lasers.[63] However, their relatively high cost and poor portability and movement issues make them unattractive for the orthodontic set-up.[63] Soft-tissue penetration depth for a CO_2 laser is approximately 0.2 mm[66,70]; for erbium lasers (Er:YAG and Er,Cr:YSGG) it can be as shallow as 5 µm.[66,68] CO_2 lasers have the highest absorption in hydroxyapatite and calcium phosphate and must be used with care during soft-tissue procedures to avoid direct contact with hard tissue.[66] Absorbed at the tissue surface with very little scatter or penetration[1] the CO_2 laser beam is associated with a relatively thin layer of coagulation around the ablated site. The ablation for the CO_2 laser is basically caused by heat generation (charring or carbonization).[1] Erbium lasers have the highest absorption into water, and they target water or the hydroxide ion as primary targets and mineral as a secondary target, and, therefore are used for ablation of both hard and soft tissues.[66] Erbium lasers provide the most rapid, favorable, and uneventful wound healing due to their precise ablation with minimal thermal effects and their low inflammatory response.[70] However, hemostasis is less effective with erbium lasers because of the minimal tissue denaturation, which guarantees subsequent sufficient bleeding and blood clot formation in the ablated defects and, thereby, induces favorable wound healing.[6] Overall, erbium lasers provide the highest absorption into water, minimizing the thermal effects on the surrounding tissues during irradiation; however, the cost, relatively poor laser portability and movement, and less clear-cut incision morphology compared with CO_2 and diode lasers[70] are potential drawbacks for erbium lasers in orthodontic practice.

Tissue Ablation: Noncontact or Contact Cutting Mode

Most surgical lasers produce a photothermal effect on soft tissue, evaporating the tissues by thermal effects. Noncontact lasers such as CO_2 or erbium lasers (Er:YAG and Er,Cr:YSGG) directly and easily evaporate soft tissues by photothermal effects. However, diode lasers used in dentistry do not have sufficient power to cut tissue in a noncontact mode, and therefore, the laser tip needs to be activated (initiated) by touching a substance to create a charring effect on the tip.[71,72] In this process, part of the emitting light in diode lasers, as well as in Nd:YAG lasers, is converted into heat by refraction or diffused reflection at the tip end; the laser tip end gets initiated, creating a condition called "hot tip." This initiation produces a secondary thermal effect at the heated tip end that can cut or incise soft tissue and offer coagulation of the tissue as a result of contact with the overheated tip rather than by the laser energy itself.[1,2] Diode and Nd:YAG lasers produce a relatively thicker coagulation layer on the treated surface than superficially absorbed lasers.[3]

Diode lasers are considered to be ideal for daily practice of orthodontic soft-tissue procedures because they achieve sufficient hemostasis and cut precisely.[73,74] The hydroxyapatite of tooth structure is mostly unaffected by diode laser wavelengths and the hot tip used is relatively safe around enamel without prolonged exposure, but it can leave a damaged area on root structure, dentin, or osseous tissue.[66] For the purpose of this article the use of diode lasers for soft-tissue procedures will be discussed in greater detail because of their ease of use in orthodontics and lower operating cost.

Soft-Tissue Diode Lasers

Semiconductor (diode) lasers are mainly available in 810-nm to 830-nm, 940-nm, 980-nm, and 1064-nm wavelengths[63,67]; the 810-nm to 980-nm lasers are used most frequently. Diode lasers demonstrate high absorption coefficients in hemoglobin, particularly in oxyhemoglobin. However, diode laser light is poorly absorbed by hydroxyapatite and enamel[62,63]; thus, the diode laser is an excellent soft-tissue surgical laser for incising, excising, and coagulating gingiva and mucosa. The active mediums of semiconductor (diode) lasers are varied and can include aluminum (Al), gallium arsenide (GaAs), and occasionally indium.[63,75,76] Examples are gallium-aluminum-arsenic (Ga-Al-As), arsenic-gallium (As-Ga), and indium-gallium-aluminum-phosphide (In-Ga-Al-P) lasers. Besides being portable (<5 Kg), small, relatively inexpensive, and simple to use, diode lasers have a stable power output, long lifetime, and low installation and maintenance costs.[75]

Fiberoptic Tip Size, Power Output, and Continuous/Pulsed Mode

The diode laser is delivered by a fine glass fiber with a fiber system tip that can be angled, so that the dentist can hold it similar to a pencil for accurate manipulation, which is especially beneficial in difficult-to-handle areas.[75] For surgical incisions and excision, a 400-µm-diameter fiberoptic tip is recommended, because smaller-diameter fibers tend to be more friable.[76] The fiberoptic tip requires initiation prior to performing surgical excision; this is often done by tapping the initiated tip on a thick blue articulating paper, using black ink or a solid color in a magazine page, or using a piece of cork.[63,73,77] Diode lasers with power outputs of <500 mW are used in LLLT to provide biomodulation, wound repair, and pain relief.[63] However, to perform excision a continuous power output of 1 W to 1.5 W is often needed,[77] depending on the fibrotic nature of the tissue. To decrease carbonization and thermal damage and allow for thermal recovery of the tissue, the pulsed mode has been suggested and implemented in many contemporary diode laser units.[78]

Anesthesia and Basic Soft-Tissue Guidelines

Diode laser soft-tissue surgery is often performed using local infiltration (eg, 2% lidocaine) approximately 5 minutes before the procedure; however, literature also reports using topical lignocaine anesthetic gel, applied for 3 minutes,[79] or nonregulated compound topical anesthetics such as TAC Alternate for 3 minutes (20% lidocaine, 4% tetracaine, and 2% phenylephrine).[76,77,80] To confirm adequate anesthesia prior to laser soft-tissue surgery, the clinician can gently probe the soft tissue.

Following surgical excision, the soft-tissue margins can appear dark and charred (carbonized), and the use of a high-speed suction is recommended to remove laser plume and objectionable charred odor.[76,77] The remnants of carbonized tissue at the surgical margins can be removed using sterile gauze dampened with saline[79] or a microapplicator brush soaked in 3% hydrogen peroxide solution.[77]

Various manufacturers present different arrangements for diode lasers with respect to output power, diameter of fiber, and wavelength. Though these parameters may influence collateral tissue damage, there is currently a lack of standardization in setting optimum parameters of diode laser for orthodontic soft-tissue procedures, a matter that should be investigated in future studies.[81]

Diode lasers are useful in recontouring the gingiva to gain access to the clinical crown in cases of gingival overgrowth or partially erupted teeth, which prevents the proper positioning of a bracket. When planning laser soft-tissue procedures, the general guideline is to leave at least 1 mm of pocket depth and preserve at least 2 mm of keratinized tissue to avoid further soft-tissue complications such as gingival recession.[63] The aforementioned guidelines are based on the "biologic width" concept, as measured from the free gingival margin to the crestal bone, which is approximately 3 mm, consisting of, on average, 1 mm of junctional epithelium, 1 mm of connective tissue attachment, and a gingival sulcus depth of approximately 1 mm.[63,76] To decide whether to use a conventional flap approach or laser gingivectomy, the gingivectomy location should be probed, and the amount of attached gingiva, the location of the crest of bone, and the desired amount of crown lengthening should be considered based on the limitations of the biologic width. In other words, an average of 3 mm of soft tissue will rebound (regrow) coronal to the alveolar crest in about 3 months.[82]

Laser Gingivectomy to Improve Oral Hygiene or Bracket Positioning

Gingival enlargement or hyperplasia is a common side effect of fixed orthodontic therapy, occurring in almost 10% of orthodontic patients.[81,83] Gingival enlargement often impedes the maintenance of oral hygiene, causing esthetic and functional problems, and has been reported to compromise orthodontic tooth movement.[81,84,85] Conventional treatment for gingival enlargement often includes oral hygiene instruction, scaling, root planing, and prophylaxis; however, extensive and often fibrotic gingival enlargement compromises self-care and may necessitate gingivectomy to maintain oral health.[81,86] The adjunct use of diode laser gingivectomy can in a shorter amount of time further improve the gingival health of a patient with gingival enlargement.[81] Figure 1 through Figure 4 depict a case of gingival hyperplasia that was successfully managed using diode laser.

In addition, laser gingivectomy can be performed to remove excess soft tissue and expose the crown of a partially erupted tooth, allowing brackets to be placed properly—ideally in the center of the teeth—to enable an improved level of hygiene maintenance during treatment (Figure 5 through Figure7).[63,87]

Esthetic Laser Gingival Recontouring

Oftentimes during treatment or when debonding a case, the clinician may come across unsightly gingival margins that do not conform to the principles of smile esthetics and present with short or uneven crown heights, disproportionate tooth proportionality ratios, and unesthetic enlarged and fibrotic interdental papillae and gingival margins.[7] Procedures to improve esthetics such as crown lengthening or papillae flattening can be technically demanding tasks in that the gingival margins sometimes need minor recontouring that requires a higher degree of precision than that achieved with a scalpel blade, regardless of the operator's skill level.[88] Diode lasers offer precise incision control because of minimal bleeding and a clear, dry field during surgery. Figure 8 and Figure 9 show a female patient who underwent localized gingival recontouring of the maxillary left central and lateral incisors.

Laser Exposure of Superficially Impacted Teeth

One of the interesting applications of diode lasers is for exposure of superficially impacted teeth, in particular maxillary permanent canines, which are the most frequently impacted tooth after third molars (0.92% to 4.3%).[89,90] The conventional approach is to orthodontically create sufficient space for the impacted tooth and wait for it to erupt, which could delay treatment for months and adversely affect treatment efficacy. Alternatively, an apically positioned flap (buccally/labially positioned tooth) or full-thickness mucoperiosteal flap (palatally positioned tooth) could be raised using closed/


Fig 1.


Fig 2.


Fig 3.


Fig 4.

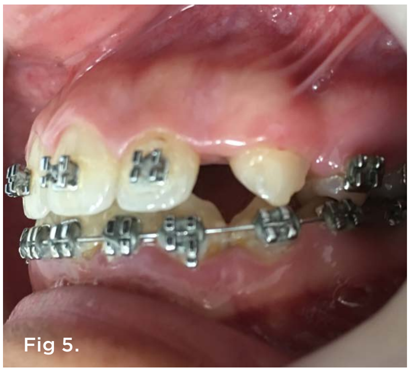
Fig 5.


Fig 6.


Fig 7.

Fig 1 through Fig 4. A female patient with gingival hyperplasia in the esthetic zone after removal of orthodontic wire; the enlargement of the interdental papilla is evident (Fig. 1), following gingivectomy (Fig 2), after cleaning the carbonized tissue with 3% hydrogen peroxide (Fig 3), and 2 months following the debond process (Fig 4). **Fig 5 through Fig 7.** Excess soft tissue on partially erupted canine (Fig 5) was removed enabling more exposure of the tooth (Fig 6) prior to bracket placement (Fig 7).

open eruption techniques, and an orthodontic attachment subsequently bonded to the impacted tooth.[77,91,92] This would involve use of a scalpel, leading to considerable bleeding and pain. Bonding orthodontic attachments requires a dry field and use of hydrophilic moisture-insensitive primers.[92] The orthodontic traction should begin as soon as possible after exposure if the open eruption technique is not intended.[92]

The localization of the impacted tooth prior to laser exposure is vital to establish whether


Fig 8.


Fig 9.


Fig 10.

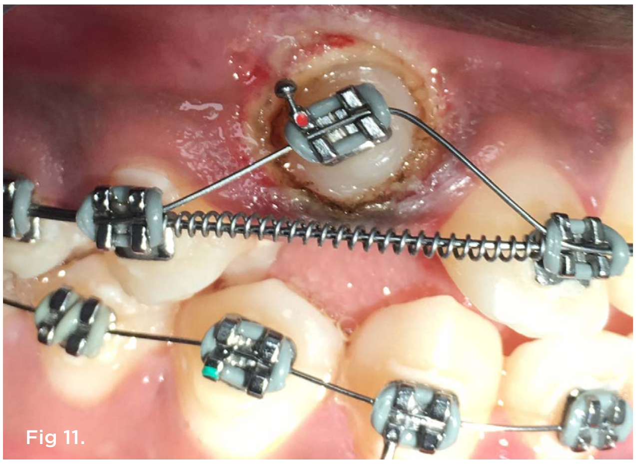
Fig 11.

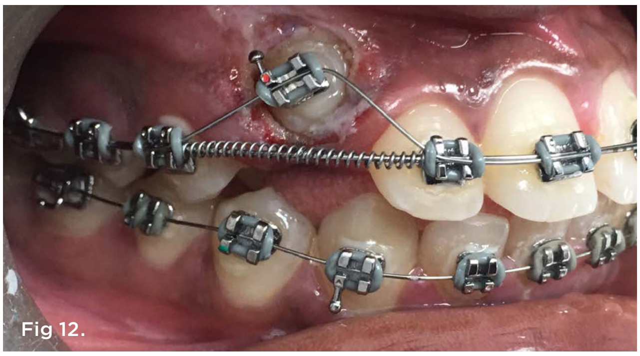
Fig 12.

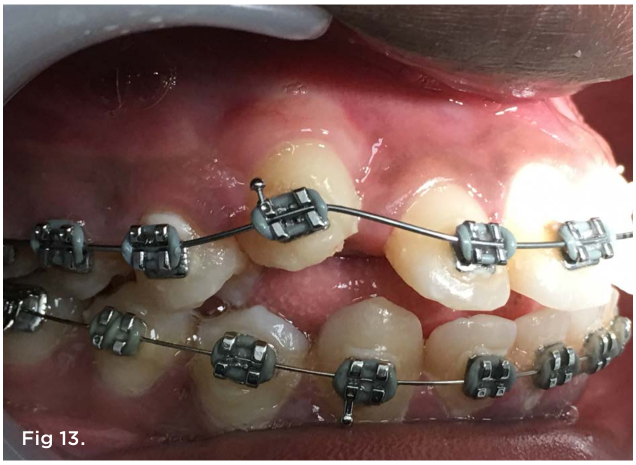
Fig 13.

Fig 8 and Fig 9. Preoperative view (Fig 8) of a patient who underwent localized gingival recontouring of the maxillary left central and lateral incisors; and just after gingivectomy (Fig 9). **Fig 10 through Fig 11.** A male patient with a buccally impacted maxillary right canine (Fig 10) is shown right after laser exposure (Fig 11), at 24 hours post-treatment (Fig 12), and after nearly 6 weeks' follow-up (Fig 13).

the impacted tooth is positioned superficially and is not covered completely by bone, or referral to an oral surgeon or periodontist is needed. The clinician carries out visual inspection and digital palpation; however, the presence of a labial bulge does not guarantee access to the crown after soft-tissue exposure, as a clinical crown might be fully covered by alveolar bone. The localization should be based on both clinical (ie, blanching of tissue with finger pressure) and, if there is any doubt, supplemental radiographic examination.[93] Approximately 85% of canine impactions occur palatally and 15% buccally.[93-95]

Diode laser exposure is not applicable in cases of impaction of teeth fully covered by cortical bone. In these cases a conventional full-thickness mucoperiosteal flap (palatal impaction) or an apically positioned flap (buccal impaction) and removal of cortical bone until the crown portion of the retained tooth is exposed may be necessary. When superficially impacted teeth are present, it is recommended that sufficient space be created before the surgical laser exposure to facilitate bonding an eyelet or bracket and applying orthodontic forces immediately after laser exposure.[92]

Figure 10 depicts a male patient with a

Fig 14.

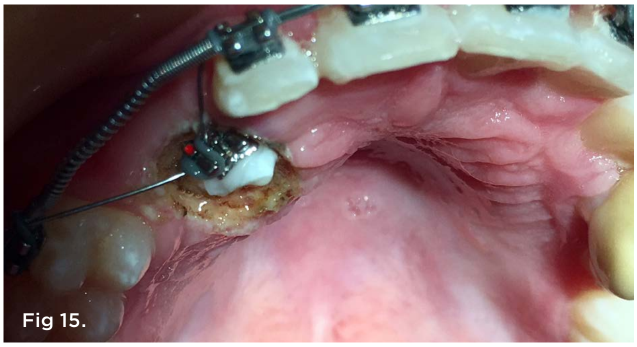

Fig 15.

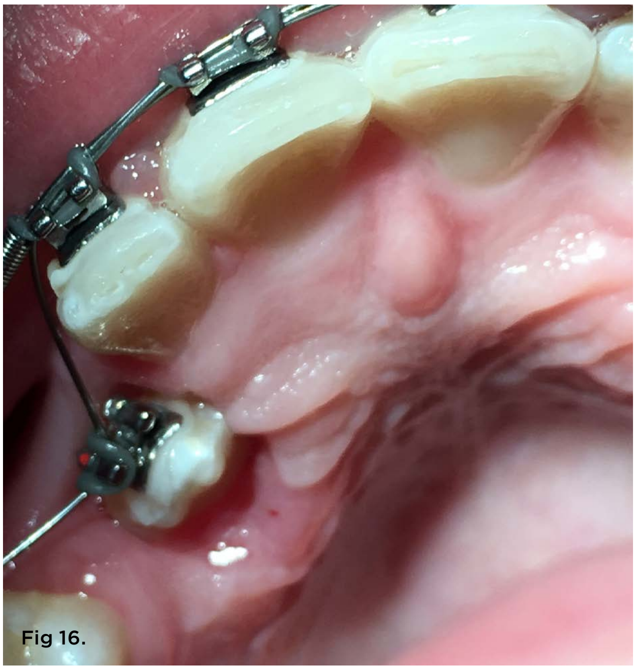

Fig 16.

Fig 17.

Fig 14 through Fig 17. Male patient with a palatally impacted maxillary right canine (Fig 14) is shown right after palatal laser laser exposure (Fig 15), a relatively dry field that facilitates orthodontic bonding procedure, at 2 weeks post-treatment (Fig 16), and after 4 months' follow-up. (Fig 17).
Note: The thick and healthy band of keratinised tissue associated with the maxillary right canine.

buccally impacted maxillary right canine. Figure 11 shows the tooth immediately after laser exposure, and Figure 12 shows it 24 hours after the laser treatment. Note that the amount of inflammation is minimal. Figure 13 illustrates the laser exposure site at approximately 6 weeks' follow-up.

Superficially palatally impacted permanent maxillary canines are good candidates for laser exposure (Figure 14 through Figure 17). The remarkable healing process can be seen in a male patient with a palatally impacted maxillary right canine (Figure 14), immediately after palatal laser exposure (Figure 15), and at 2 weeks post-treatment (Figure 16). Finally, at 4 months' follow-up (Figure 17) a thick band of keratinized gingiva is evident. Such laser exposure treatment on a superficially palatally impacted canine can be used as an alternative to a full-thickness mucoperiosteal flap.

All cases demonstrated were performed using a 940-nm InGaAsP diode laser (Epic™ 10, Biolase, www.biolase.com), with a 400-µm diameter fiberoptic tip, and after initiation.

Postoperative Instruction

Postoperatively, the lased area should be kept clean, using a soft-bristle toothbrush (or cotton swab), or rinsing the mouth with salt water several times daily for a few days and removing any remaining tissue with a wet cotton swab.[7,63] Vitamin E gel can be rubbed over the treated area to aid in healing and keep the area moist, and over-the-counter analgesics can be taken such as acetaminophen for pain control.[63,81]

Other Soft Tissue Orthodontic Applications and Future Research

Diode lasers have been used to uncover temporary anchorage devices (TADs), perform frenectomies where highly attached frenum is impeding tooth movement in diastema cases, remove operculum on mandibular second molars that prevents banding, or improve healing of minor aphthous ulceration following placement of fixed orthodontic braces.[7,63,77] Presently, there is limited information on the variables the affect the efficiency of diode lasers for soft tissue procedures (continues of pulsed mode, wavelength, power output, fiber optic diameter). [96] Further, the diode laser family is also expanding and there is a need for further research. [97,98]

Summary

The adjunct use of a diode laser can potentially improve the esthetic outcome of orthodontic treatment, decrease treatment duration in situations where surgical exposure of superficially impacted teeth is needed, and collectively reduce the number of appointments. Compared to conventional scalpel surgery, lasers offer a quicker, bloodless, and less painful alternative with improved healing potential.

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CONTINUING EDUCATION 2 QUIZ | 2 Hours CE Credit

The Adjunctive Soft-Tissue Diode Laser in Orthodontics

Ali Borzabadi-Farahani, DDS, MScD, MOrth RCS (Ed), Fellowship (Craniofac Orth, CHLA/USC)

THIS COURSE IS AVAILABLE ONLINE AT: COMPENDIUMLIVE.COM/GO/ORTHODONTICS2. ENTER PROMO CODE: ORTHO2

1. Compared to conventional scalpel usage or electrosurgery, increasing evidence shows that the appropriate use of lasers is associated with reduced:
A. intraoperative and postoperative pain.
B. wound healing.
C. tissue regeneration.
D. All of the above

2. As the diode laser cuts it also:
A. leaves a moist field.
B. achieves poor hemostasis.
C. sterilizes.
D. exacerbates inflammation.

3. What can promote changes at the cell level and expression of cytokines that can collectively support wound healing?
A. Scalpel surgery
B. Photobiomodulation
C. Use of short duration pulses
D. Nitric oxide release

4. Which type of soft-tissue laser operates in the 800-nm to 980-nm range?
A. Carbon dioxide (CO_2)
B. Erbium (Er:YAG)
C. Neodymium doped yttrium-aluminum-garnet (Nd:YAG)
D. Diode

5. Diode lasers are ideal for use in orthodontic set-up because:
A. of the relatively small size of the laser device.
B. they represent a much deeper penetration depth compared to Nd:YAG lasers.
C. of their high absorption coefficient in water.
D. they are extremely stationary.

6. Erbium lasers provide uneventful wound healing due to their precise ablation with:
A. high inflammatory response.
B. minimal thermal effects.
C. a high level of tissue denaturation.
D. low absorption into water.

7. Which of the following is mostly unaffected by diode laser wavelengths?
A. Hydroxyapatite of tooth structure
B. Soft-tissue margins
C. Gingival hyperplasia
D. Gingival recontouring

8. For surgical incisions and excision, because smaller-diameter fibers tend to be more friable what size fiberoptic tip is recommended?
A. 1 W to 1.5 W
B. <5 Kg
C. 1064-nm wavelength
D. 400-µm-diameter

9. Following surgical excision with a diode laser, soft-tissue margins can appear dark and charred; the use of what is recommended to remove laser plume and charred odor?
A. Thick blue articulating paper
B. Pulsed mode
C. High-speed suction
D. Prophylaxis

10. A common side effect of fixed orthodontic therapy, gingival enlargement or hyperplasia occurs in what percentage of orthodontic patients?
A. Approximately 75%
B. 50%
C. More than 25%
D. Almost 10%

Course is valid from 3/1/2017 to 3/31/2020. Participants must attain a score of 70% on each quiz to receive credit. Participants receiving a failing grade on any exam will be notified and permitted to take one re-examination. Participants will receive an annual report documenting their accumulated credits, and are urged to contact their own state registry boards for special CE requirements.

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